13279556

88006369

MONTHLY ALERT
Edition JUN 1985
Item No. 270
File SK 353 M61 no. 166

RETENTION COPY

BLM LIBRARY
88006369

8-224

QL
737
.U5
I78
1984

RESPONSE OF ELK TO SEISMIC EXPLORATION
IN THE
BRIDGER-TETON FOREST, WYOMING

PROGRESS REPORT

By

Dr. Larry L. Irwin, Assistant Professor
and
Colin Gillin, Graduate Research Assistant
Department of Zoology and Physiology
The University of Wyoming

1 October 1984

Cooperators: Bureau of Land Management; International Association of Geophysical Contractors; U.S. Forest Service; Wyoming Game and Fish Department.

QL
737
.U5
I78
1984

INTRODUCTION

This report describes activities and progress from 1 September 1983 through 1 September 1984 on a project designed to accomplish 2 major goals associated with relationships between elk and geophysical exploration: (1) provide quantitative field research information regarding responses of elk to seismic disturbance; and (2) integrate results of field studies and critical literature review into a series of recommendations, or alternatives, for allowing seismic exploration to occur with the least environmental consequences to elk.

It has been noted that many stipulations associated with seismic operations vary from one forest or range district to another because of variable perceptions of the potential impacts of seismic operations on elk. Without quantitative information, permit officers have naturally adopted a conservative, or restrictive, course. No one has provided a truly credible definition of consequences that cause measurable damage. For example, if disturbance causes elk to be temporarily displaced, is the displacement harmful? Or, if permanent, can elk simply adjust, to the new environment, with minor biological problems?

Our aim, is to provide as clear a picture as possible regarding actual and potential effects of seismic exploration on elk to allow more standardized guidelines to be formulated. However, we also see the need for flexibility within the regulatory process, provided it is based upon factual field evidence and informed interpretations of the literature. It is not our intent to suggest rigid rules,

ACKNOWLEDGMENTS

This portion of the study was funded by the U.S. Forest Service and the International Association of Geophysical Contractors. The Wyoming Game and Fish Department supplied invaluable supportive assistance with a truck and trailer and supplied flight money. During this field season numerous people assisted us, both in the field and with supportive information and their time; we wish to express our thanks to all of them.

University of Wyoming

- Brian Miller
- Kenneth Logan
- Tony Raymond
- Mary David

Bureau of Land Management

- Larry Doughty
- Bruce Baker
- Jim Roseberry

Wyoming Fish and Wildlife Coop. Unit

- Stan Anderson
- Fred Lindzey
- Angela Brummond

CGG Land Seismic, Inc.

- Rick Woodward
- Bill Wells
- Fred Buchart
- Jacques Tisne

Sohio Oil Company

- Rob Orman

Thermix Energy Corporation

- Mark Hansen

U.S. Forest Service

- Mark Hinschberger
- Jay Carlson
- Bob Hitchcock
- Lorin Ward
- Paul Shields
- Bob Gale
- Jack Capp
- Dave Garber
- Ron Escaño

Wyoming Game and Fish Depart

- Bruce Johnson
- Chuck Thornton
- Tom Toman
- Elaine Raper
- Tom Ryder
- Lynn Jahnke
- Cathy Gillin
- Bill Hepworth
- Harry Harju

Western Air Research, Inc.

- Fred Reed

Exxon Oil Company

- Cheryl Winkler

Bureau of Land Management
Library
Bldg. 50, Denver Federal Center
Denver, CO 80225

which may be appropriate in some localities but may be highly abrasive in others, owing to the variations in elk populations, topography, food and cover regimes, and relationships to other forms of disturbances.

This progress report was written in 3 parts. Part I describes literature reviewed to date on: (1) the potential effects of seismic activities on elk, based upon studies of a more or less general nature; and (2) documented studies of seismic activities relative to big game. Part II consists of preliminary results of our field studies of radio-collared elk in relation to seismic activities near Big Piney, Wyoming. Part III includes a discussion of logistical problems, financial needs, and future plans for the remainder of this project, which is scheduled for completion on 30 September 1985. Conclusions and recommendations will be made in the final report.

PART I: LITERATURE REVIEW

POTENTIAL EFFECTS OF SEISMIC ACTIVITY ON ELK

Because there are no significant habitat losses associated with seismic disturbance, biologists must monitor behavioral and physiological responses of wildlife. These responses lie within two primary but related categories: displacement and stress, as well as their associated problems.

Displacement

One way that seismic disturbance may potentially affect elk after they are displaceed from traditional areas could be via increased predation. Traditional calving areas, may be chosen by elk because of their relative safety from predators, as appears to be the case for caribou (Miller 1972, Klein, unpubl.). Thus, distubance-related abandonment of traditional calving areas could result in increased rates of predation, as Miller (1972) found for caribou and Schlegel (1976) suggested for elk vs. black bears in Idaho. It has been observed that elk no longer have their calves in Snider Basin in our study area, apparently due to a variety of disturbance-related causes. Following such range abandonment it may take many years for elk to regain old patterns of range use (Batchelor 1968, Craighead et al. 1972).

If range abandonment occurs, it results in consequent reduction in total range occupied and a reduction in recreational opportunities, which is interpreted as a loss by game management agencies. Snowmobile harassment was implicated in the decrease via range abandonment of a wintering elk herd in northeastern Oregon (Anderson and Scherzinger 1975). The same occurred with experimental harassment of red deer in New Zealand (Batchelor 1968).

Displacement may also result in harmful expenditures of energy. The energetic cost of rapid travel (i.e., fleeing) varies with the distance traveled, temperature, speed, and amount of climbing. Hard running can exceed by 20 times the cost of basal metabolism (Brody 1945, Mattfeld 1974), and climbing requires about 12 times as much energy as locomotion on level terrain.

The cost of such high energy expenditures is usually thought to be highest in winter when ungulates are in an energy conservation mode (Moen 1973, Verme 1969). This is why disturbance is kept to a minimum on winter ranges. However, tremendous energy flux also occurs in summer when elk must get rid of large amounts of heat (Bubenik 1982). Thus, they use higher elevations and cool, moist thickets. During warm summer days, there is a tremendous cost of movement (Geist 1982), which, if excessive, could cause thermal damage to tissues and organs. This is particularly true for large bulls that may be forced to run uphill. Geist suggested that if a bull already shedding heat maximally under a hot sun was disturbed by a helicopter, it could collapse from heat stroke after running away.

Displacement also may cause elk to use habitats with reduced food-intake opportunities. In an experiment with red deer (which is now regarded as the same species as elk), heavy hunting and harassment were purposely used in the best habitats. Areas of poor habitat were undisturbed. Disturbed deer showed reduced reproductive rates and reduced body size, used unfavorable escape terrain, and were nocturnal. They remained in poor habitats for 2 years after disturbance ceased (Douglas 1971).

Apparently, displacement to poorer habitats causes problems for at least 2 reasons. First, associated excitation and social pressures from meeting established animals in new areas results in reduced feeding and feeding on poor quality foods (Bubenik 1982). Second, in poor foraging habitats, elk must feed longer to fill the rumen. However, food passage rates are reduced when elk eat low quality foods, so they may not be able to compensate by feeding longer. Cows entering autumn in poor condition for either reason breed later, and produce late-born calves or calves which are lighter in weight. Late-born calves and those with lighter birth weights are expected to have nearly twice the rate of neonatal mortality as normally-born calves (Clutton-Brock et al. 1982).

Displacement may also result in physical damage. Bighorn sheep have been observed to fall from cliffs after being chased by helicopters (Hansen 1967), and Saiga antelope chased by cars (Bannikov et al. 1961) and reindeer displaced in cold weather (Zhigunov 1961) seriously damaged their lungs.

On the other hand, it has been shown that even hunted populations can become accustomed to alarming events which are localized and highly predictable, such as camp-ground disturbances or highway traffic (Ward 1976, Geist 1982). We have observed a seismic helicopter repeatedly take off and land 400m away from over 700 elk at a feed-ground near Alpine, Wyoming with no displacement of the elk.

Apparently, because the helicopters were repetitive and not associated with unpredictable threatening events such as explosions and humans advancing toward the elk, the elk did not exhibit escape behavior. However, some may be quick to point out that displacement movements do not always follow alarm which can cause stress (MacArthur et al. 1979), which is discussed below.

In summary, most studies on the impacts of human disturbance on big game animals have been short-term, baseline inventories that have indeed indicated big game were displaced. Such displacement lasted typically from a few days to several weeks (Altmann 1958, Ward et al. 1973, Marcum 1975, Dorrance et al. 1975, Moen 1978). However, these studies precluded either immediate or long term interpretations of effects on big game population dynamics. Thus, traditional ecological impact analyses have focused on losses, often predicted mortality, without considering limiting factors and factors affecting distribution.

However, predictions of mortality are inadequate for estimating effects as long as the habitat continues to provide the potential for a big game population to respond to increased mortality, just as hunted species are capable of responding to hunting mortality. This is true as long as the disturbed animals are not forced into poor-quality habitats or completely abandon traditional ranges. Thus, the focal point of the disturbance-displacement-impact issue was described by Tyus and Lockhart (1979) as needing more detailed examination of population regulation factors. Unfortunately, very little quantitative information is available describing how displacement influences overall population distribution, reproduction, and survival (MacArthur et al. 1979).

Stress

Stress is a complex physiological state of an animal resulting from adverse environmental stimuli which may include actual tissue damage as well as a complex of psycho-neural stimuli such as unfamiliar objects, people, or sounds (Prism 1982). Psycho-neural stressors produce alarm, excitation, fear, anxiety, or apprehension, which can lead to various physiological responses, which, in turn, affect potential for survival and reproduction.

For example, chronic stress produces elevated glucocorticoid levels which inhibit antibody production, reduce white blood cells, and inhibit healing (Geist 1979). Noise and vehicular harassment have been associated with elevated glucocorticoid levels in moose, mule deer, and feral horses. Disturbance of reindeer produced excessive weight loss, reduced reproducton, and increased frequency of disease (Zhigunov 1961), probably resulting from elevated glucocorticoid levels. Even pastoral herding of domestic ungulates creates a state of chronic, low-level alarm, resulting in significantly reduced physical condition. Reduced resistance to pneumonia was implicated in a stress-related all-age die-off of Rocky Mountain Bighorn sheep in Waterton Canyon, Colorado, during road and dam construction (Spraker and Hibler 1977).

Stress may influence reproductive success by increasing abortion of implanted embryos (domestic sheep), reduced ovulation and menstrual upsets (baboons), and pregnancy toxaemia in sheep. In pregnant sheep, young may be damaged before parturition, or act abnormally after birth. In addition disturbance causes panic among reindeer, causing internal displacement of fetuses, producing difficult and slow delivery, especially for those giving birth for the first time (Baskin 1970). Trampling or desertion of newborn calves may occur (Zhigunov 1961). It is not known if similar responses are shown by elk, although the potentials do seem to exist.

Stress can occur without movement (MacArthur et al. 1979), so disturbance can be harmful even if the animals are not displaced. When excited, such as by disturbance, ruminants select the toughest or hardest foods (Larsson 1954, Bubenik 1982). Thus, prolonged excitement may inhibit the food drive (Bubenik 1982), and elk could potentially enter the winter in poor condition.

Unfortunately, most studies associated with stress have been conducted in laboratory situations. However, there are many problems in measuring thresholds of detrimental responses to stress in the field because free-living animals can mediate stressors via interactions with their environment. It can be said that additional stress from any source is probably harmful when big game are in a negative energy balance (e.g., already stressed, say, due to winter deprivation). Biologists need to know the effects of stress due to seismic activities, not simply that disturbance creates stress. Certainly, all animals are well-equipped to withstand certain levels of stress. Big game, for example, have been evolved to withstand social pressures, stress of predators, fire, and thunderstorms. We often do not know if disturbance-related stress reaches thresholds of tolerance, or if it adds cumulatively to other factors which create stress.

STUDIES OF RESPONSES OF BIG GAME TO SEISMIC ACTIVITIES

Probably the most quantitative elk study in relation to seismic activities was conducted in Michigan by Knight (1980), who monitored 13 radio-collared elk in an unhunted population 2-3 days before and 10 days after seismic activities in which explosives were detonated underground. The study area contained habitat types composed primarily of aspen and upland hardwoods. Few natural openings occurred. Elk fed primarily under heavy forest cover, unlike most elk in the Bridger-Teton Forest, or elsewhere in the Overthrust Region. Knight tested various habitat parameters to determine if vegetation, topography, or escape cover influenced the elk displacement response, but he found no correlations. This appeared to occur because habitat variation and elk density was low, so displaced elk always could find suitable habitats.

On the other hand, Basile (1973) and Allen (1977), working on elk in relation to human disturbances along forest roads in Montana, observed that responses of elk do, indeed, vary depending upon forest density and structure. Responses to disturbance are reduced in dense forest situations, apparently because of increased security cover. Thus, Knight's (1980) conclusions appear not to be fully applicable to pine, Douglas-fir, lodgepole, and spruce-fir forests of Wyoming and adjacent states, where most feeding occurs on grasses, sedges, and forbs in meadows, riparian zones, or forest parks and clearcuts.

However, Knight (1980) did find a 3- to 4-fold increase in daily movements of elk that were within 1000 m of seismic activities. The increased movements tended to disrupt breeding activities, because bulls were forced to spend much time re-grouping scattered harems. If the rates of movement, topography, and temperature are known, one could calculate the approximate caloric value of energy expenditures of the increased movements. Since elk normally move about 1000 m in a day (Craighead et al. 1972, Irwin 1978), the frequency and duration of disturbances would probably become highly important.

Knight (1980) also observed that cows with young calves were much more reactive to disturbance than were other classes. Apparently, elk are adapted to expend large amounts of energy in parental care. It has been observed, however, that female red deer with calves older than 3 weeks of age are not so protective of their calves, and pay little attention to their calves when danger approaches (Clutton-Brock and Guinness 1975).

Horejsi (1979) studied responses of big game to seismic activities in the Kakwa River area, Alberta. In that area, seismic lines are cut through the forest, similar to electric power line rights-of-way. The seismic work was conducted using up to 12 tracked vehicles and 5 bulldozers on as many as 4 seismic lines at once. Preceding the drills by 1-2 days was a chaining crew which marked shot hole locations. Usually last was a 2-man surveying crew. The geophones and lines were moved using a Bell 206 helicopter. Horejsi concluded that moose used the cut seismic lines less during seismic activity than before or after. Apparently, few observations were made on elk using the area. The author concluded that the stress burden to moose and elk was limited and not likely to exceed that imposed by hunting disturbance.

However, big game densities were apparently quite low, as only 26 total crossings of seismic lines were collectively made by elk, moose, mule deer and caribou. Also, the study lasted for only 6 weeks during a period of abnormally light snowfall, so the conclusions only can be considered tentative.

Olson (1981) monitored 6 radio-collared elk in relation to seismic activities in the area of the South Fork of the Two Medicine River, Montana. Two elk were in an undisturbed area. During seismic work, elk were displaced and remained in heavy timber with 1-2 ridges between the elk and the disturbance. The 4 experimental elk appeared to show 30-50% more movement between observations, compared to the 2 control elk. Sample sizes were too low (64 relocations) to test if changes occurred in habitats selected or if the displacement caused elk to spend more time in lesser quality foraging areas.

There have been 2 elk-seismic studies in Wyoming, both of which are case-history examples not designed to be detailed, experimental studies. Hoskins (1981) conducted an observational study of general elk distributions in the vicinity of a seismic line in the Bighorn Basin south of Cody. He noted that wintering elk moved when seismic activity was within 5 km. All movements resulting from seismic activity occurred within 1 day after disturbance, but no significant changes in home ranges appeared to occur. It was not known how far the elk moved. Thus, the direct and indirect effects of those movements on elk nutrient and energy regimes were unknown.

Ward (1984) monitored unmarked and radio-collared elk responses in winter in the vicinity of seismic activities along the Little

Snake River south of Rawlins, Wyoming, where 3 different seismic methods were used. The area is very open but is dissected by a series of small mountains, buttes, and drainages, with sagebrush cover in most areas and aspen thickets on north slopes. Elk generally moved at least 0.5 mile (800 m) from seismic activities and preferred to stay out of the line of sight, some up to 2 miles away. Although there were several distributional changes associated with seismic activities, undisturbed elk showed similar changes, possibly because a variety of alternative areas was present. Ward was unable to distinguish any difference in elk response to the presence of humans and their response to noise associated with seismic activities. He concluded that hunted populations of elk are displaced by seismograph activity on winter range with no forest cover for security. However, because elk readily returned within a few days, and undisturbed animals also showed shifts in distribution, there probably were no detrimental effects from the seismic operations.

Bangs and Bailey (1982) conducted a controlled experiment to evaluate the effects of seismic disturbance on hunted, but relatively undisturbed, adult moose in the Kenai National, Wildlife Refuge, Alaska. Nearly 30 moose were radio-collared and monitored for 13 months in each of 2 areas to determine movements, behavior, and habitat use differences that might be attributed to seismic activities. Seismic exploration lines were established on a 2 mile (3.2 km) grid in 1 area. Each line had 12 shot points per mile, using 36 pounds of explosives detonated above ground. Helicopters were used to transport men and equipment. Sound pressures from the shots ranged from

137dB at 280 m to 81dB at over 13 km. Detonations within 1 km caused noise levels between 137dB to 106dB, decreasing rapidly beyond 1 km. (The pain threshold for the human ear is about 130dB.) Approximately 173 km of lines, or 1,300 detonations were surveyed.

Seismic activity had no obvious effect on most moose, but on 5 occasions marked moose in open habitats ran to nearby cover in apparent response to seismic activity within 100 m. Conversely, some moose ignored seismic activity within 100 m. They concluded seismic activity was compatible with moose in periods of low snow. The authors cautioned that different results might have been obtained in a normally harsh winter or with moose that had not had a long history of mostly benign contact with humans.

In summary, these studies of seismic effects on big game were only able to show little more than displacement and inferred the potential costs of the movements. Very few studies examined habitat use changes to address the potential of animals being displaced to poor quality habitats. One study (Ward 1984) examined the minimum altitude for a helicopter to displace elk (approx. 500 feet). Few studies monitored marked animals frequently enough to determine total distance moved, the rate of movement, or the average time before returning. No big game study was able to detect range abandonment as a result of seismic effects. Also, none of the studies examined cumulative effects of a series of disturbances. Thus, although definite potentials exist for serious damage to big game populations to be caused as a result of geophysical activity, no study has been able to directly measure it. This has occurred mainly because there are many difficulties to overcome in conducting controlled field studies. We believe the design of our project will help overcome at least some of these difficulties.

METHODS

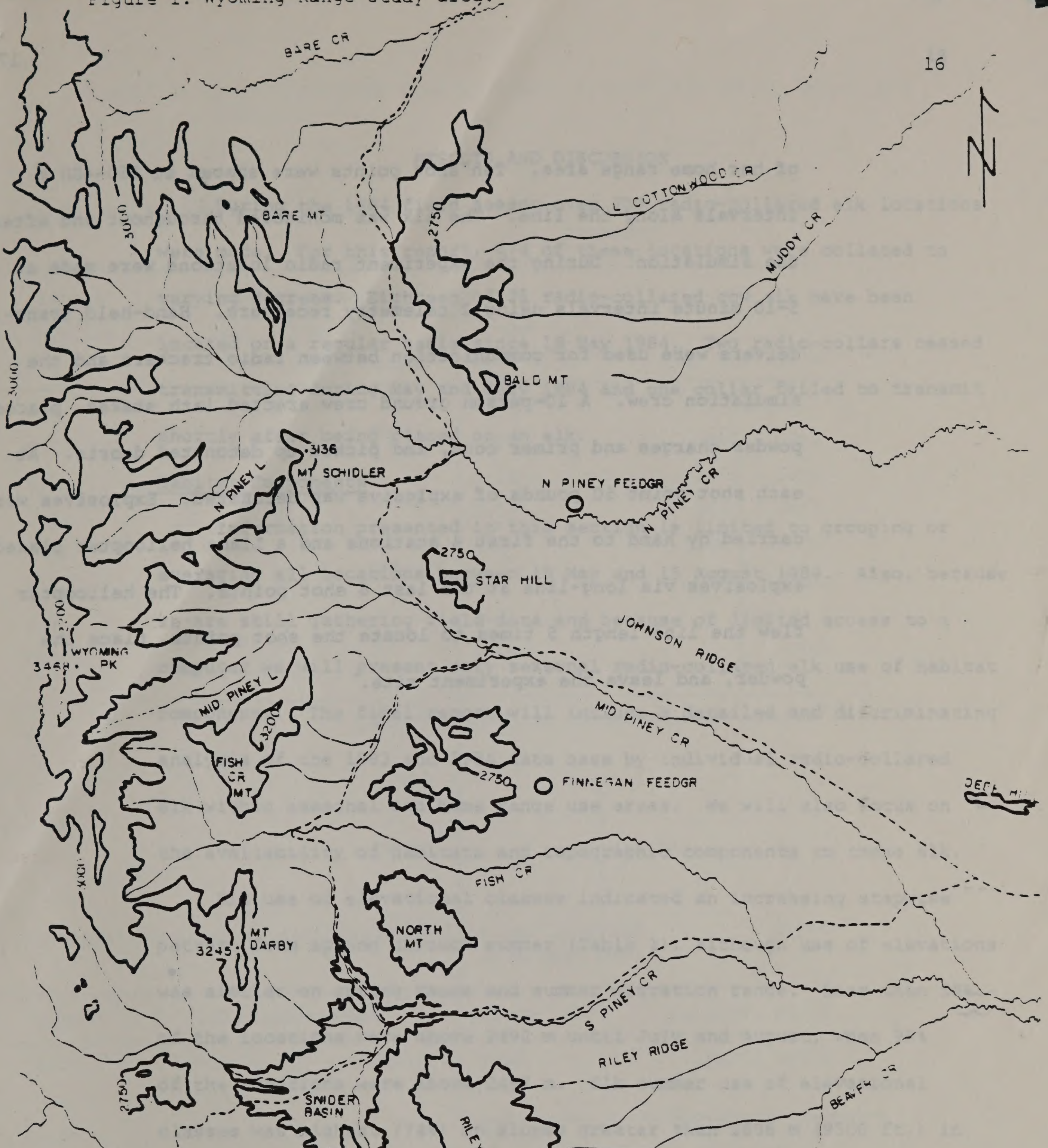
Fifteen radio-collared elk were captured using Sucostrin, fitted with radio-collars and released during winter 1984 on the Finnegan elk feedground, maintained by the Wyoming Game and Fish Department (see Study Area Map, Figure 1). Total radio-collared elk on the study area include 21 with the 6 from the 1983 field season. Spring and summer telemetry locations were made by project personnel via ground tracking, supplemented by weekly telemetry flights using fixed-wing aircraft.

Ground locations were made principally by triangulation using multiple compass bearings on each radio-collared elk over a period of time (i.e., 10 minutes or less between compass readings taken simultaneously by two field personnel).

Locations were plotted on USFS and BLM habitat type maps to determine stand size, dominant overstory species, and stand crown density. In addition, habitat information collected for each radio location included slope, aspect, elevation, position on slope, general under- and overstory composition, distances to water, the nearest cover or feeding site, roads (by classification) and maintained trails. Site specific habitat measurements taken throughout the study area at random locations also included measurements of stems per acre, tree diameter at breast height, canopy closure, and sight distances.

Techniques were developed for conducting a seismograph simulation which was completed immediately prior to development of this report. A radio-collared elk with a small and predictable home area was located several days prior to the simulation. That day a two-man flagging/survey crew laid out a 2.3 km line passing through the center

Figure 1. Wyoming Range study area.



of her home range area. Ten shot points were spaced at 250-400 m intervals along the line. The elk was monitored throughout and after the simulation. During the experiment radio locations were made at 5-10 minute intervals using 2 telemetry receivers. Hand-held transceivers were used for communication between radio trackers and the simulation crew. A 10-person ground crew erected lath stakes, placed powder charges and primer cord, and picked up detonated debris. At each shot point 50 pounds of explosive was detonated. Explosives were carried by hand to the first 4 stations and a Llama helicopter placed explosives via long-line at the last 6 shot points. The helicopter flew the line length 5 times to locate the shot points, place the powder, and leave the experiment site.

RESULTS AND DISCUSSION

During the 1984 field season over 700 radio-collared elk locations were made. For this report, 474 of these locations were collated to varying degrees. Eighteen of 21 radio-collared cow elk have been located on a regular basis since 18 May 1984. Two radio-collars ceased transmitting during May and July 1984 and one collar failed to transmit shortly after being placed on an elk.

Habitat Components

Information presented in this section is limited to grouping or averaging all locations between 18 May and 15 August 1984. Also, because we are still gathering field data and because of limited access to a computer we will present only seasonal radio-collared elk use of habitat components. The final report will include a detailed and discriminating analysis of the 1983 and 1984 data base by individual radio-collared elk within seasonal and home range use areas. We will also focus on the availability of habitats and topographic components to these elk.

Elk use of elevational classes indicated an increasing stepwise pattern from spring through summer (Table 1), although use of elevations was similar on spring range and summer migration range. Less than 50% of the locations were above 2492 m until July and August, when 96% of the locations were above 2492 m. Elk summer use of elevational classes was highest (74%) on slopes greater than 2896 m (9500 ft.) in comparison to spring use (0%) and summer migration (1%). Table 2 illustrates this information with elk use of slope positions. We found that elk use the upper third of slopes during summer (53%) almost as frequently as their use of the lower third in spring (54%). Figure 2

Table 1. Seasonal use of elevations by radio-collared elk, 1984 (Percent)

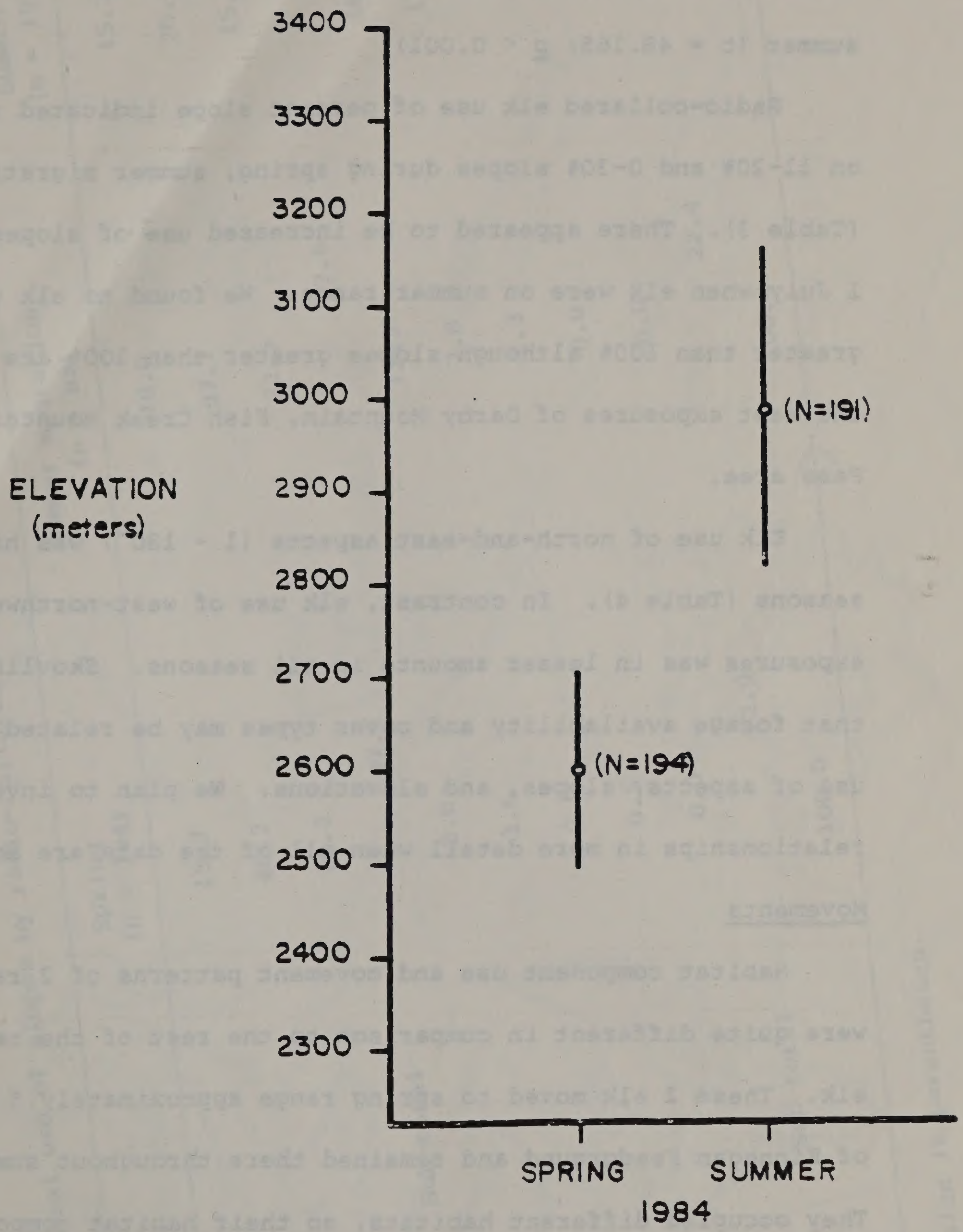
Elevation (M)	Spring 18 May-1 July (n = 194)[a]	Summer migration 31 May-7 July (n = 89)	Summer 1 July-15 Aug (n = 191)
< 2439	2.6	0.0	0.0
2439 - 2591	52.3	33.7	3.9
2492 - 2743	31.6	46.1	6.3
2744 - 2895	13.5	19.1	15.7
28.96 - 3048	0.0	1.1	31.9
3049 - 3200	0.0	0.0	33.5
> 3200	0.0	0.0	8.9
Total	100.0	100.0	100.0

[a] Number of relocations is in parentheses.

Table 2. Seasonal use of slope positions by radio-collared elk, 1984 (percent)

Slope position	Spring	Summer migration	Summer
lower third	53.9	36.0	7.8
middle third	32.1	47.2	39.3
upper third	14.0	16.3	52.9

Figure 2. Mean elevations used by radio-collared elk during Spring and Summer, 1984.



illustrates mean elevations for spring use was 2600 m (sd = 103.9) and summer use was 2990 m (sd = 166.8). There was a statistically significant difference between elk use of elevations during spring and summer ($t = 48.165$; $p < 0.001$).

Radio-collared elk use of percent slope indicated use was highest on 11-20% and 0-30% slopes during spring, summer migration and summer (Table 3). There appeared to be increased use of slopes > 30% after 1 July when elk were on summer range. We found no elk use on slopes greater than 100% although slopes greater than 100% are available on the east exposures of Darby Mountain, Fish Creek Mountain and the Cheese Pass area.

Elk use of north-and-east aspects ($1 - 180^\circ$) was highest in all seasons (Table 4). In contrast, elk use of west-northwest (271°-315°) exposures was in lesser amounts in all seasons. Skovlin (1982) stated that forage availability and cover types may be related to elk seasonal use of aspects, slopes, and elevations. We plan to investigate these relationships in more detail when all of the data are analyzed.

Movements

Habitat component use and movement patterns of 2 radio-collared cows were quite different in comparison to the rest of the radio-collared elk. These 2 elk moved to spring range approximately 5 - 7 km north of Finnegan Feedground and remained there throughout summer (Figure 3). They occupied different habitats, so their habitat components were analyzed separately and were not included in Tables for this report. However we briefly summarize their use patterns. From 18 May - 15 August 94% of the locations of both elk were below 2590 m (8500 ft.), and 97% were located on the lower third of slopes. Use of eastward

Table 3. Seasonal use of slopes by radio-collared elk, 1984 (percent)

Slope (%)		Spring (n = 194)		Summer migration (n = 89)		Summer (n = 191)	
< 10		19.7		18.0		15.2	
11 - 20		48.2		37.1		20.4	
21 - 30		19.2		22.5		15.7	
	Sub-total		87.1		77.6		51.3
31 - 40		8.8		12.3		16.8	
41 - 50		3.6		7.8		17.8	
51 - 60		0.0		2.3		7.8	
61 - 80		0.5		0.0		5.8	
81 - 100		0.0		0.0		0.5	
	Sub-total		12.9		22.4		49.7
Total		100.0		100.0		100.0	

[a] Sample size in parentheses.

Table 4. Use of aspects by radio-collared elk, 1984 (percent)

Aspect		Spring (n = 194)[a]		Summer migration (n = 89)		Summer (n = 191)	
1 - 45°	(N-NE)	20.7		12.3		10.5	
49 - 90°		26.9		13.5		15.7	
91 - 135°	(E-SE)	15.0		45.0		23.6	
136 - 180°		14.0		12.3		12.6	
	Sub-total		76.6		83.1		62.4
181 - 225°	(S-SW)	9.8		3.4		8.9	
276 - 270°		1.6		9.0		11.0	
271 - 315°	(W-NW)	2.1		0.0		8.9	
316 - 360°		9.8		4.5		8.9	
	Sub-total		23.3		16.9		37.7
Total		99.9		100.0		100.0	

[a] Sample size in parentheses.

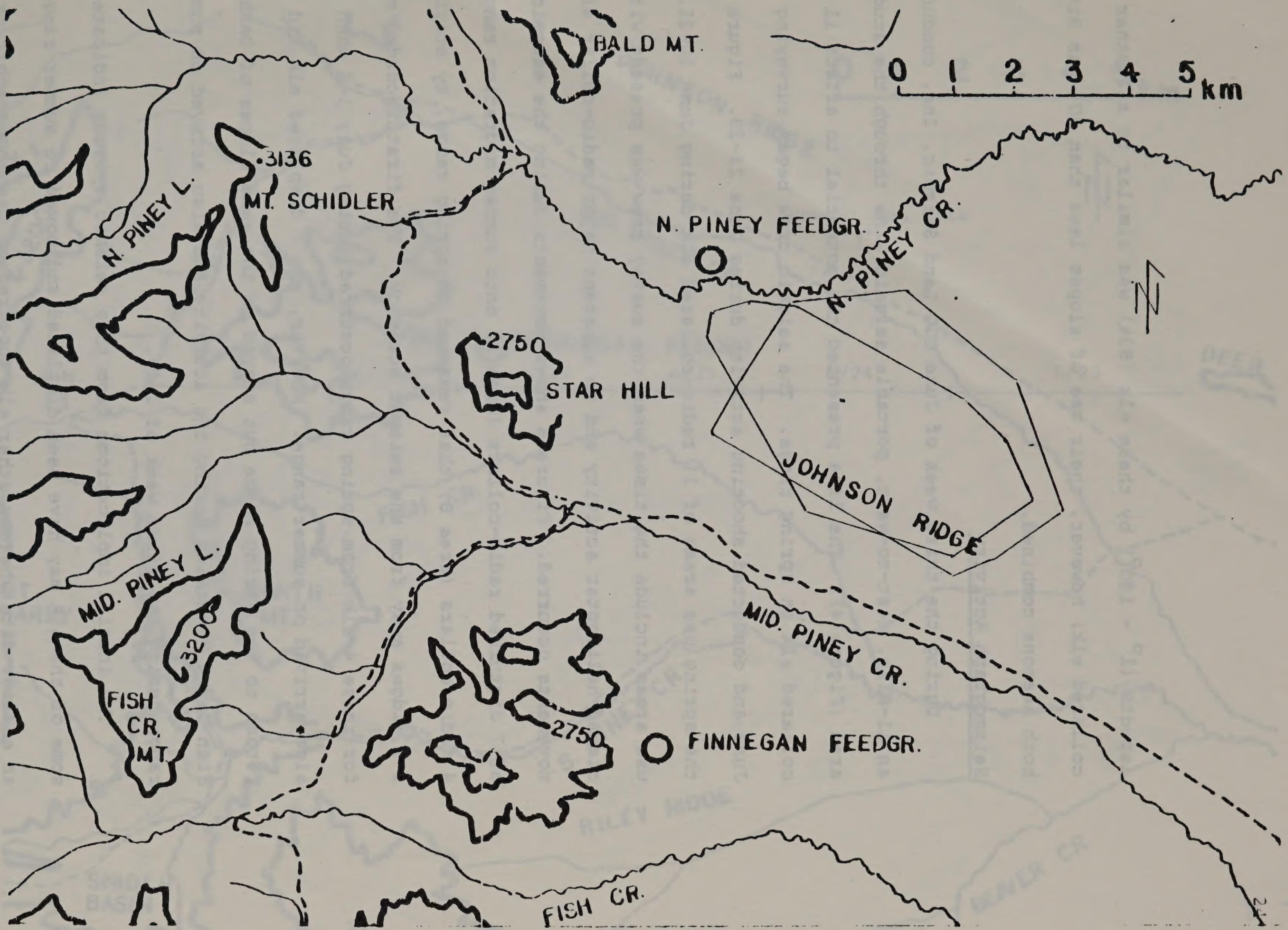


Figure 3. Use areas of two radio-collared elk Spring-Summer, 1984.

aspects (1° - 180°) by these elk (83%) was similar to all other radio-collared elk; however, their use of slopes less than 30% was 91% for both seasons combined.

Seismograph Activity

During the third week of June CGG Land Seismic, Inc. conducted an 11-mile, east-to-west, portable seismic line through the study area (Figure 4). The line presented the potential to affect 11 radio-collared elk on spring range. The seismic crew began surveying on 12 June and conducted shooting activity during June 23-28. Figure 5 shows the spring use areas of 11 radio-collared elk during June 10-21. These use areas include the times when the survey crew was present with associated helicopter activity and no apparent major radio-collar elk movements occurred. Figure 6 shows movements during the seismic shots of 7 disturbed radio-collars (area A) onto summer migration range and 4 radio-collars (area B) that remained on spring range, by staying 1-2 ridges away from the seismic activity. The first recorded movement for these 4 elk from spring range occurred during July 1-7 when they also arrived on summer range. However, the 7 displaced elk did not return to the spring range but stayed on the east slopes of Darby and Fish Creek Mountains during the activity and also arrived on summer range during the first week of July.

The initial implications from this seismic episode indicates that some of the elk may have been displaced and moved to summer range at an earlier date whereas other elk appeared to use topographic or habitat barriers to separate them from the disturbance.

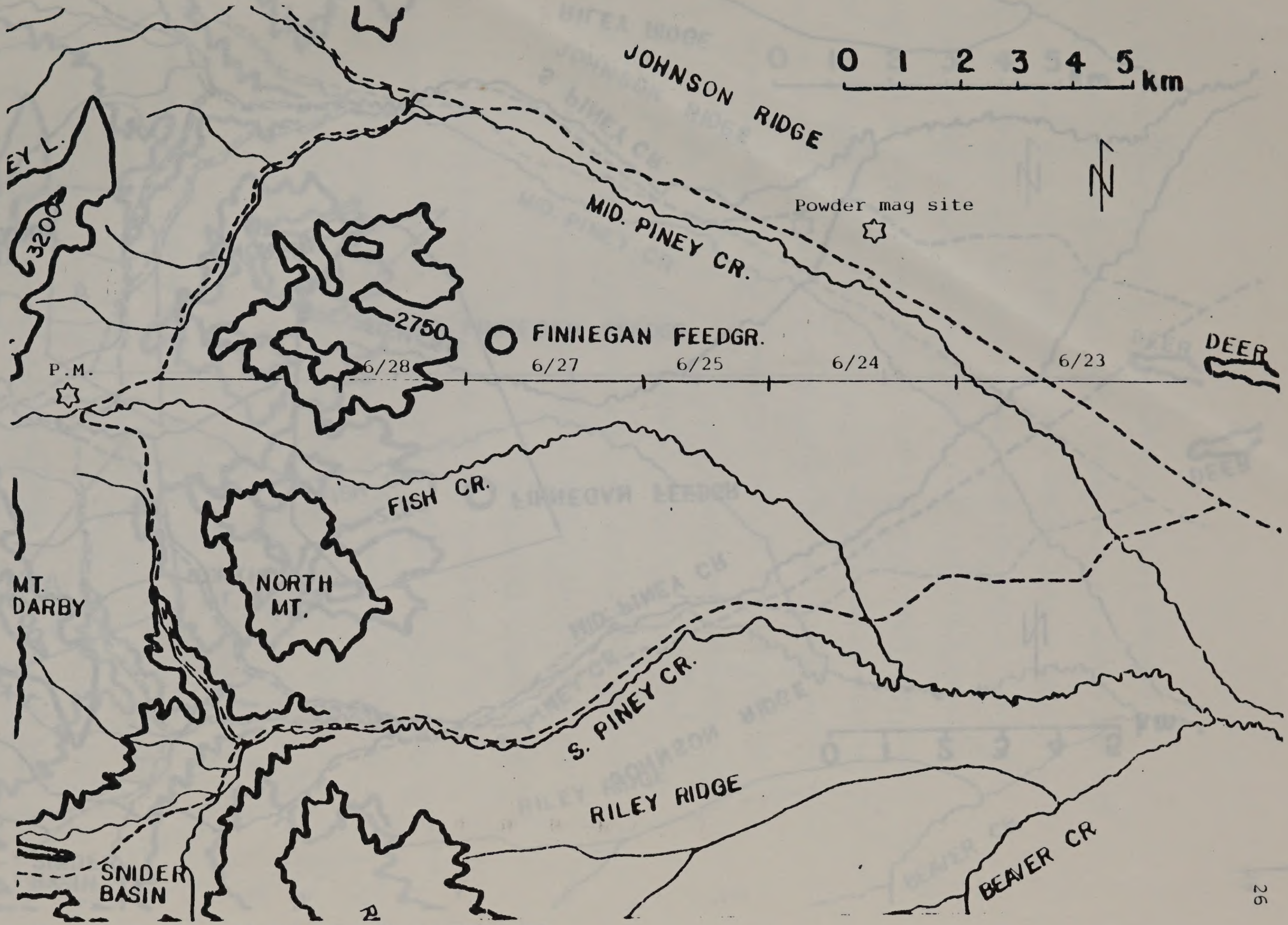


Figure 4. CGG line #4 during June 23-28, 1984

Figure 4. CGG line #4 during June 23-28, 1984

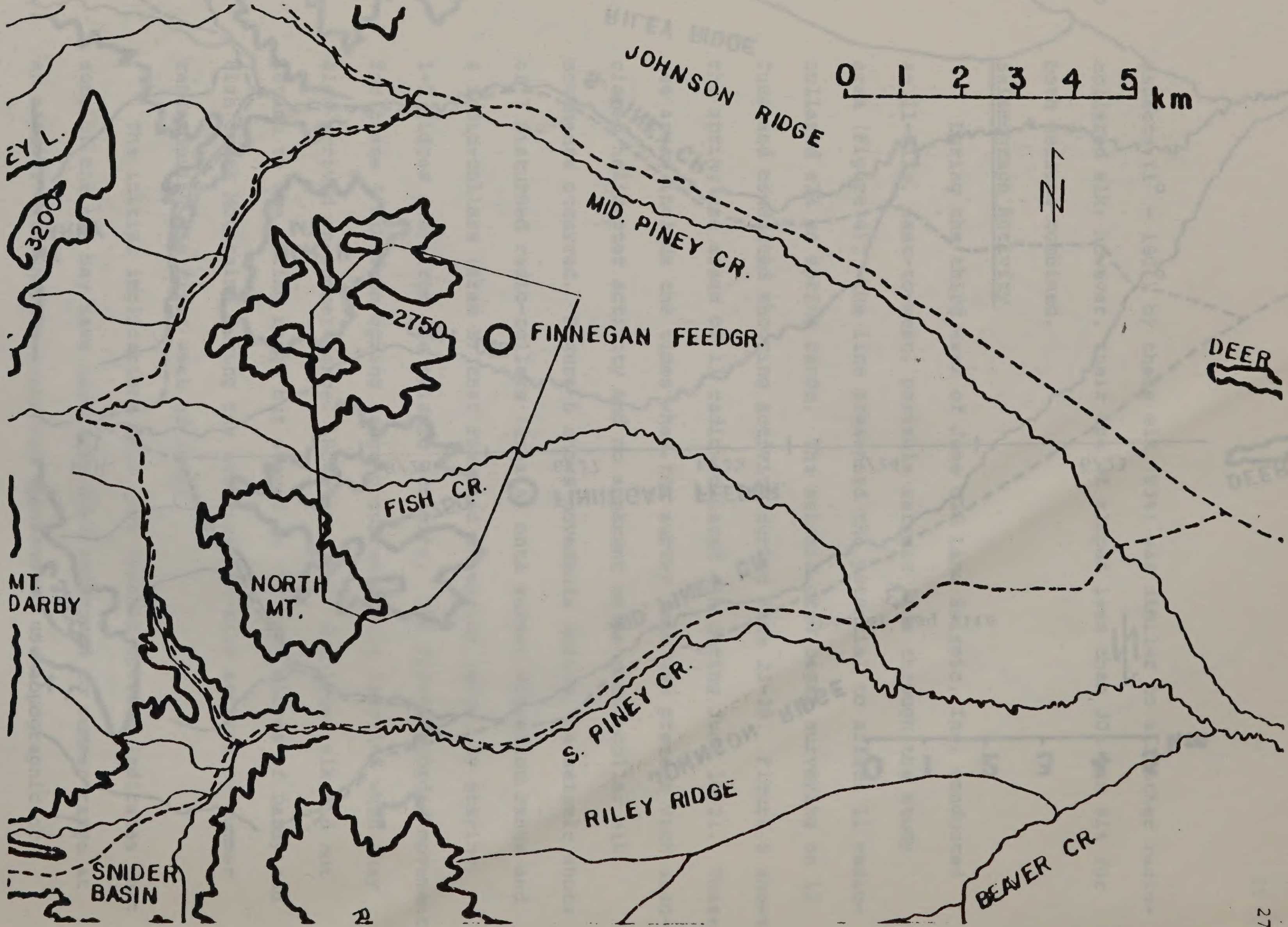


Figure 5. Spring use areas of 11 radio-co[illegible]ed elk during June 10-21, 1984.

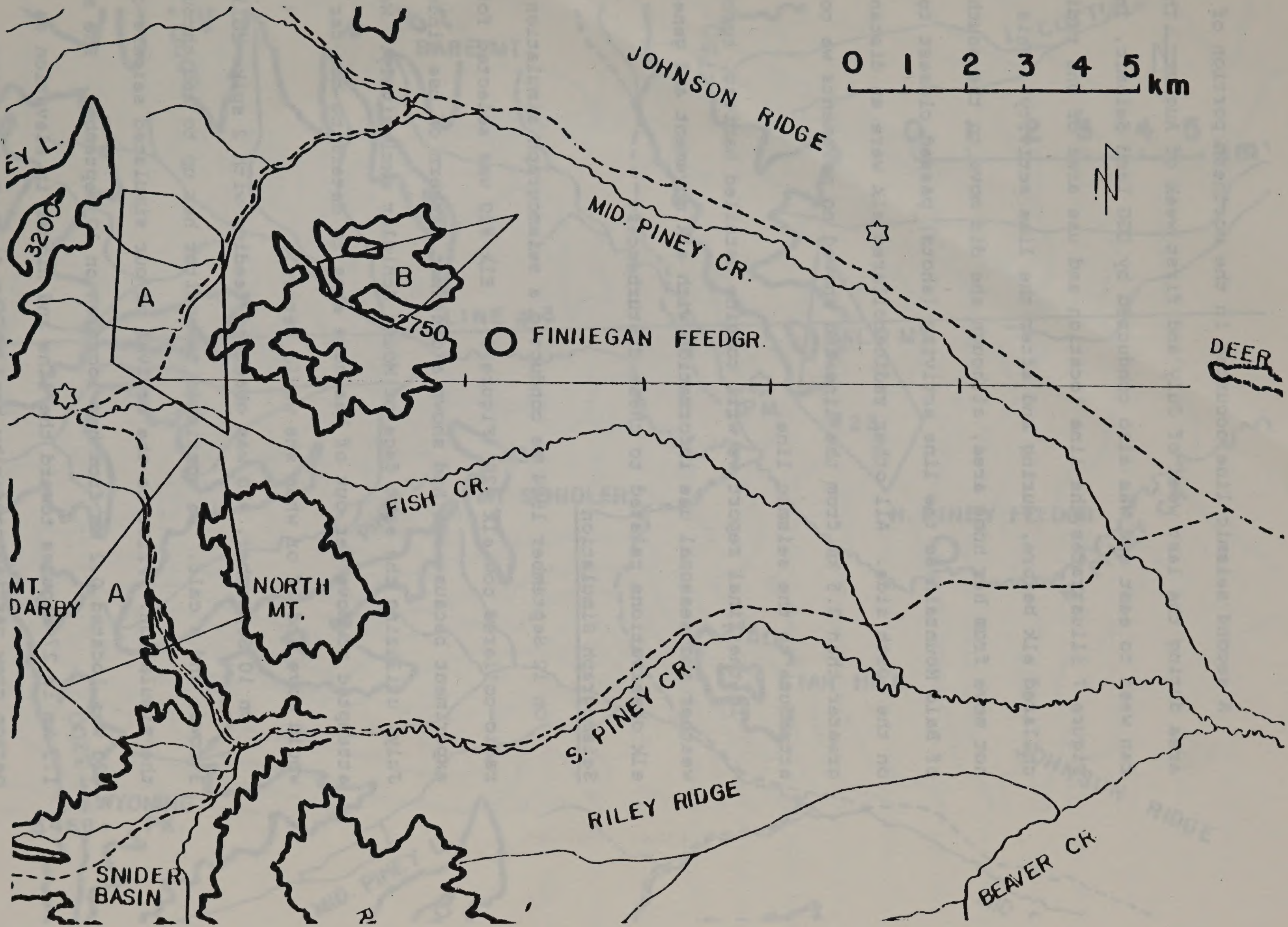


Figure 6. Use areas of 7 radio-collars (areas A) and 4 radio-collars (area B) during seismograph activity June 23-28, 1984.

A second seismic line occurred in the northern portion of the study area during the last week of July and first week of August. This line ran west to east and was also conducted by CGG Land Seismic, Inc. Figure 7 illustrates the line location and use area of one radio-collared elk before, during and after the line activity. This elk did not move from her home area, although she did move to the south side of Bald Mountain as the line activity (shots) passed closest to her on the north side. All other radio-collared elk were at distances greater than 2.5 km from the line and showed no movements we could attribute to the seismic line.

In the final report we will combine detailed habitat, topographic, weather and seasonal use information with elk movement and general elk observations related to these disturbances.

Seismograph Simulation

On 12 September 1984 we conducted a seismograph simulation on radio-collared cow elk #20 (Figure 8). Elk #20 was selected for this experiment because she had shown a distinct pattern of use since early July, utilizing the east face of Mount Schidler exclusively. We attempted to move her out of her home area to determine how far she would move and if or when she would return.

On 10 September, #20 was observed feeding with 2 spike bulls, 3 cows, and a calf. We continued to monitor her up to and throughout the simulation. Prior to the arrival of our simulated seismic crew #20 was located 0.2 km from her location on 10 September. She moved 1.3 km in 27 minutes toward the line and higher in elevation as the 10 person crew carried powder by hand to the first 2 shot points.

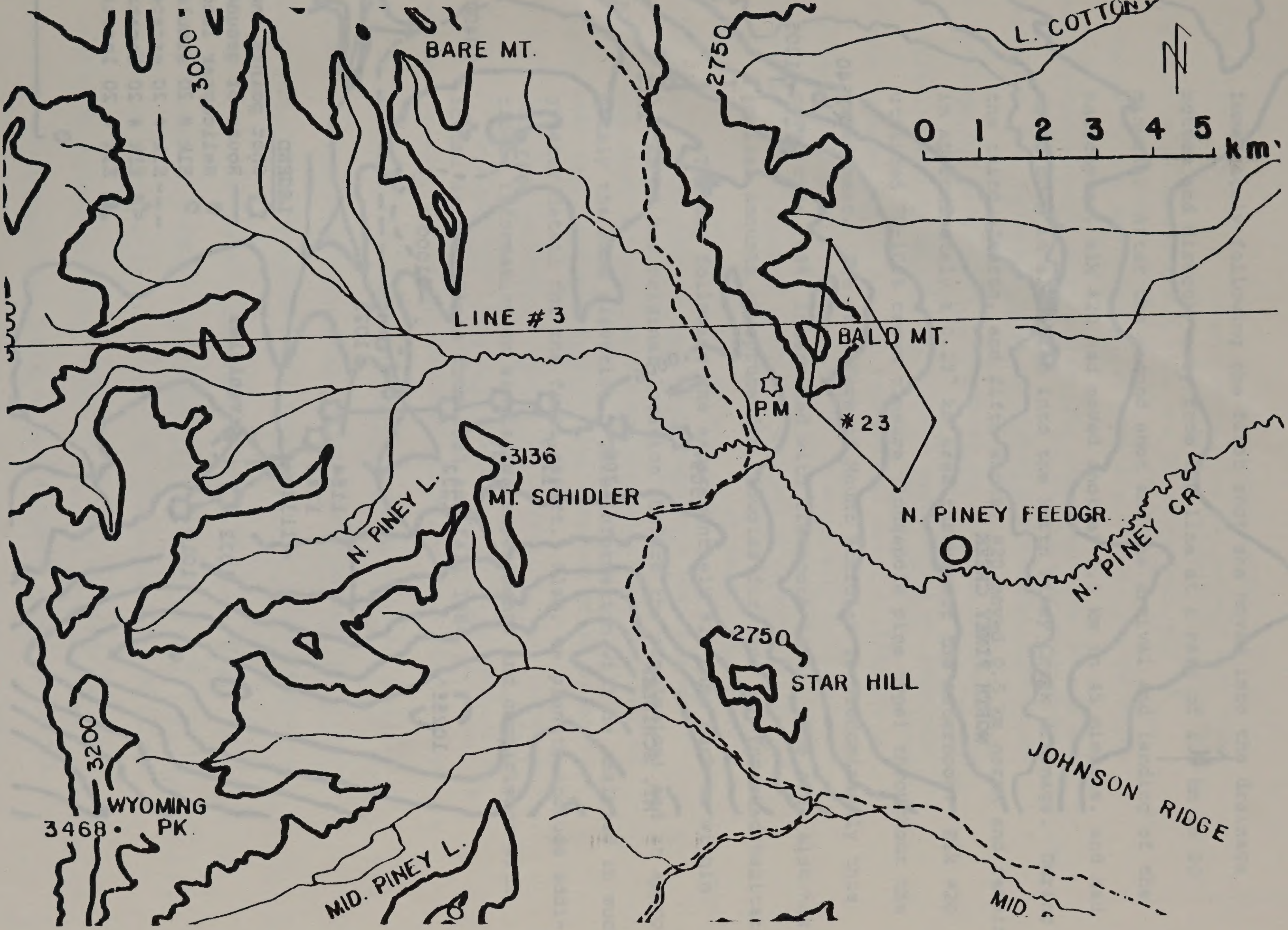
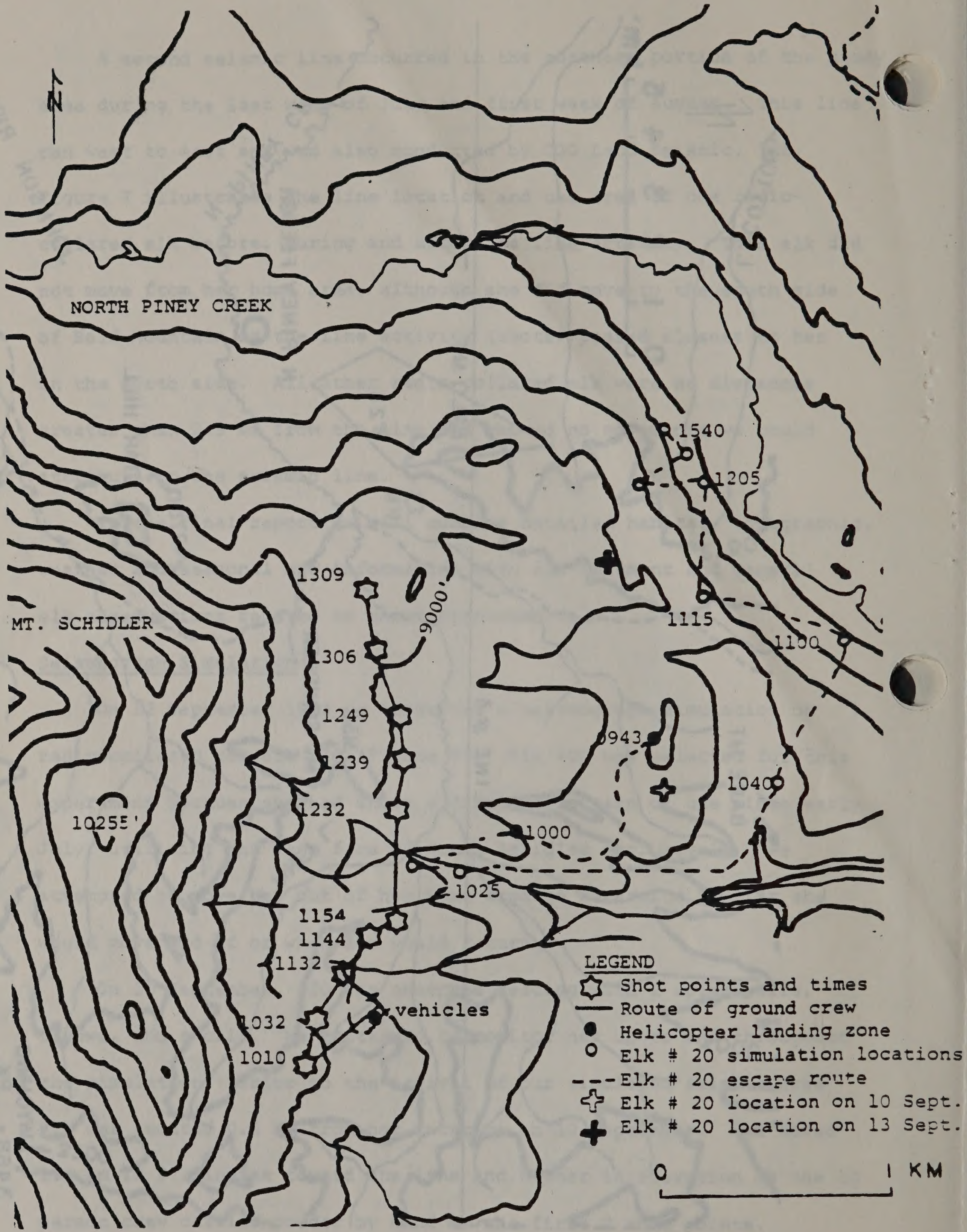


Figure 7. CGG line #3 July 24-August 6, 1984 and radio-collared elk #23 location before, during, and after line activity.

Figure 8. Seismograph simulation on 12 September 1984 and elk #20 movements.



Immediately following the first shot she moved into the drainage bottom and directly away from the line at a rate of 1.5 km in 20 minutes. After the second shot and the arrival and landing of the helicopter, elk #20 had moved another 1.5 km in 45 minutes, and had moved down in elevation into the North Piney Creek drainage. During the third, fourth, and fifth shots, #20 moved 0.5 km north and remained in approximately a 0.25^2 km area throughout the afternoon. Elk #20 utilized 70-100% crown closure (lodgepole pine type) throughout the experiment. The east face of Mount Schidler is predominantly this cover type (48%) intermixed with clearcuts (11%). The area also has smaller amounts of spruce-fir, Douglas fir, and non-forested habitats.

The day following the experiment elk #20 came back to within 0.8 km of her original location (before the simulation) and at approximately the same elevation. This information will be analyzed in much greater detail for the final report. Also, we plan to include additional information on simulation experiments and comparisons with actual seismic lines from 1983 and fall 1984.

PART III. Logistics and Future Plans.

At the conclusion of the 1984 field season we will begin a detailed analysis of all data collected since the inception of this study. We anticipate the information will provide quantitative results which will enhance our knowledge of elk habitat use, distribution and movements in relation to seismograph activity. The analysis of elk responses to seismograph testing will focus on one seismic line conducted in 1983, 3 lines in 1984 and details of the seismic simulation discussed in this report. We are pleased with the tremendous cooperation received from federal and state resource agencies and geophysical/ seismograph companies.

We feel the strongest qualities of this study are centered around information describing elk movements, distribution, and habitat use in relation to the available disturbance data that were collected. However, due to constraints placed on funding, manpower, and timing and location of disturbances this past field season, we see two improvements which would enhance the soundness of our results and overall validity of conclusions. These involve a critical need to conduct additional seismic simulations during different seasons and to collect a larger sample of cover requirement information. During spring and early summer 1985 we are prepared to conduct additional seismic simulations and hire a habitat technician provided funding is available. We anticipate approximately 15 radio-collared elk will be available in 1985 for which we have an excellent pre-disturbance data-base. Hopefully, adequate finances can be found to take maximal advantage of the opportunities they represent.

LITERATURE CITED

Allen, E. O. 1977. (Chairman). Montana Cooperative Elk-Logging study. Progress Rep., 1 Jan-31 Dec. 1976. Mont. F. and Game Dep., Bozeman, MT.

Altmann, M. 1958. The flight distance in free-ranging big game. J. Wildl. Manage. 22:207-209.

Anderson, E. W., and R. J. Scherzinger. 1975. Improving quality of winter forage for elk by cattle grazing. J. Range Manage. 28: 120-125.

Bangs, E. E., and T. N. Bailey. 1982. Moose movement and distribution in response to winter seismological exploration on the Kenai National Wildlife Refuge, Alaska. Unpubl. Final Rep. for ARCO, Alaska, Inc., Anchorage, AK. 46 pp.

Bannikov, A. G., et al. 1961. Biology of the Saiga. U.S. Dept. Commerce, Springfield, VA.

Basile, J. B. 1973. Effectsof a road closure in the Little Belt Mountains. Proc. West. St. Elk Workshop, Bozeman, MT., pp. 132-141.

Baskin, L. M. 1970. Reindeer ecology and behaviour (Transl. from Russian). Navka, Moscow. Can. Wildl. Serv., Ottawa.

Batchelor, C. L. 1968. Compensatory responses of artifically controlled mammal populations. Proc. N. Zeal. Ecol. Soc. 15:25-40.

Brody, S. 1945. Bioenergetics and growth. New York: Reinhold Publ. Co. 1,023 pp.

Bubenik, A. B. 1982. The behavioural physiology and nutrition of European large game, Vol. 1 BLV. Munich.

Bubenik, A. B. 1982. Physiology. Ch. 3 in J. W. Thomas and D. E. Toweill (eds.). Elk of North America, ecology and management. Stackpole Books, Harrisburg, PA. 698 pp.

Clutton-Brock, T. H., and F. E. Guinness. 1975. Behavior of red deer (Cervus elaphus L.) at calving time. Behavior 25:287-300.

Cautton-Brock, T. H., F. E. Guinness, and S. D. Albon. 1982. Red deer. Behavior and ecology of two sexes. Univ. Chicago Press, Chicago. 378 pp.

Craighead, J. J., G. Atwell, and B. W. O'Gara. 1972. Elk migrations in and near Yellowstone National Park. Wildl. Monogr. 29. 38 pp.

Dorrance, M. J., P. J. Savage, and D. E. Huff. 1975. Effects of snowmobiles on white-tailed deer. J. Wildl. Manage. 39:563-569.

Douglas, M. J. W. 1971. Behaviour responses of red deer and chamois to cessation of hunting. New Zeal. J. Sci. 14:507-518.

Geist, V. 1979. Behavior. Chap. 19 In J. L. Schmidt and D. L. Gilbert (eds.). Big Game of North America. Ecology and Management. Stackpole Books, Harrisburg, PA. 494 pp.

Geist, V. 1982. Adaptive behavioral strategies. Ch. 5 In J. W. Thomas and D. E. Toweill (eds.). Elk of North America, ecology and management. Stackpole Books, Harrisburg, PA. 698 pp.

Hansen, C. G. 1967. Bighorn Sheep populations of the desert Game Range. J. Wildl. Manage. 29(4):693-706.

Horejsi, B. L. 1979. Seismic operations and their impact on large mammals: results of a monitoring program. Unpubl. rept., Mobil Oil Canada, Ltd. Calgary, Alberta.

Hoskins, W. P. 1981. Effects of portable seismic exploration activities on wintering large mammals, primarily elk, in northwestern Wyoming. Unpubl. rept., Mile-Hi Exploration, Denver.

Irwin, L. L. 1978. Relationships between intensive timber culture, big game habitats, and elk habitat use patterns in northern Idaho. Ph.D. Diss., Univ. Idaho, Moscow. 282 pp.

Klein, D. R. (unpubl.) Ecology of the Porcupine caribou herd. Alaska Coop. Wildl. Res. Unit, U. Alaska, Fairbanks.

Knight, J. E. 1980. Effect of oil and gas development on elk movements and distribution in northern Michigan. Ph.D. Diss., Univ. Mich., Ann Arbor.

Larsson, S. 1954. On the hypothalamic organization of the nervous mechanisms regulating food intake. Acta Physiol. Scandinav. 32. Suppl. 115:1-63.

MacArthur, R. A., R. H. Johnston, and V. Geist. 1979. Factors influencing heart rate in free-roaming bighorn sheep: a physiological approach to the study of wildlife harassment. Can. J. Zool. 57: 2010-2021.

Marcum, C. L. 1975. Summer-fall habitat selection and use by a western Montana elk herd. Ph.D. Diss., Univ. Montana, Missoula. 188 pp.

Matteld, G. 1974. The energetics of winter foraging by white-tailed deer - a perspective on winter. Ph.D. Diss. St. Univ. New York. 306 pp.

Miller, F. L. 1974. Biology of the Kaminuriak Barren-ground caribou. Part 2. Can. Wildl. Serv. Rep. Ser. No. 31, Ottawa, 88 pp.

Moen, A. N. 1973. Wildlife ecology. W. H. Freeman and Co., San Francisco. 458 pp.

Moen, A. N. 1978. Seasonal changes in heart rates, activity, metabolism and forage intake of white-tailed deer. J. Wildl. Manage. 42(4):715-738.

Olson, G. 1981. Effects of seismic exploration on summering elk in the two-Medicine-Badger Creek area, northcentral Montana. Mont. Dep. Fish, Wildl. and Parks. 24 pp.

Prism. 1982. A review of petroleum industry operations and other land use activities affecting wildlife. PRISM Environmental Management Consultants, Edmonton, Alberta, Canada.

Schlegel, M. 1976. Factors affecting calf elk survival in north central Idaho - a progress report. Proc. W. Assoc. St. Game Fish Comm. 56:342-355.

Tyus, H., and M. Lockhart. 1979. Mitigation and research needs for wildlife on western surface mined lands. Pp. 252-255 in G. A. Swanson (ed.). The Mitigation Symp: a national workshop on mitigating losses of fish and wildlife habitats. Colo. St. Univ., Ft. Collins. 684 pp.

Verme, L. J. 1969. Reproductive patterns of white-tailed deer related to nutritional plane. J. Wildl. Manage. 33(4):881-887.

Ward, A. L., J. J. Cupal, A. L. Lea, C. A. Oakley, and R. W. Weeks. 1973. Elk behavior in relation to grazing, forest recreation, and traffic. Trans. N. Am. Wildl. Conf. 38:327-337.

Ward, A. L. 1976. Elk behavior in relation to timber harvest operations and traffic on the Medicine Bow Range in south-central Wyoming. Pp. 32-42 in S. R. Hieb (ed.). Elk-logging-roads symp., Univ. Idaho, Moscow. 142 pp.

Ward, A. L. 1984. The response of elk to seismograph activity in the Little Snake River Known Recoverable Coal Resource Area of southcentral Wyoming. USDA Forest Service, Rocky Mountain Forest and Range Exp. Sta., Laramie, WY.

Zhigunov, P. S. 1961. Reindeer husbandry, 2nd ed. (Transl. from Russian). U.S. Dep. Commerce Clearing House, Springfield, VA.

Bureau of Land Management
Library
Bldg. 50, Denver Federal Center
Denver, CO 80225